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| 09/607,122 | 06/29/2000 | Herbert Edelsbrunner | 9220-2 | 7255 |
| 20792 | 7590 | 05/19/2004 | EXAMINER | |
| MYERS BIGEL SIBLEY & SAJOVEC | | | BRODA, SAMUEL | |
| PO BOX 37428 | | | ART UNIT | |
| RALEIGH, NC 27627 | | | PAPER NUMBER | |
| | | | 2123 | |

DATE MAILED: 05/19/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/607,122

Applicant(s)

EDELSBRUNNER ET AL.

Examiner

Samuel Broda

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 13 April 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-22,36-40,42-44 and 46 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-22,36-40,42-44 and 46 is/are rejected.
- 7) ☒ Claim(s) 20 and 21 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 April 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 5-10, 13.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

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DETAILED ACTION

1. This communication is in response to Applicants' Response to Restriction Requirement mailed on 13 April 2004. In response to the restriction requirement, Applicants elected claims 1-22, 36-40, 42-44, and 46 (corresponding to Group I) without traverse; claims 23-35, 41, 45, and 47-51 (corresponding to Groups II-V) were canceled.

Claims 1-22, 36-40, 42-44, and 46 have been examined.

Drawings

2. Applicants' formal drawings have been reviewed and approved by the PTO Draftsperson.

Claim Objections

3. Claims 20-21 are objected under 37 CFR § 1.75 as being substantial duplicates of claims 1-3. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to reject the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claim Rejections - 35 U.S.C. § 112, First Paragraph

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

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The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4.1 Claims 42-44 are rejected under 35 U.S.C. 112, first paragraph.

4.2 Regarding claims 42-44, each claim is rejected under 35 U.S.C. 112, first paragraph, as comprising a single means claim. See MPEP § 2164.08(a) and *In re Hyatt*, 218 USPQ 195 (Fed. Cir. 1983).

Claim Rejections - 35 U.S.C. § 112, Second Paragraph

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5.1 Claims 1-22 and 46 are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01.

5.2 Regarding independent claims 1, 7, 10, and 46, each claim preamble is directed to “a method of modeling a surface of an object” and the omitted steps are the steps that take the results of each claim’s final step of “homeomorphically mapping edges of a coarsest triangulation in the hierarchy back to the initial triangulation” and creating a model of the surface of the object.

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5.3 Regarding independent claim 19, this claim's preamble is directed to "a method of modeling a surface of an object" and the omitted steps are the steps that take the results of this claim's final step of "determining a simplicial homeomorphism based on the fuzzy rank" and creating a model of the surface of the object.

5.4 Regarding independent claim 20, this claim's preamble is directed to "a method of modeling a surface of an object" and the omitted steps are the steps that take the results of this claim's final step of "mapping edges of a triangulation in the hierarchy back to the initial triangulation" and creating a model of the surface of the object. Additionally, this claim omits the steps necessary to take the final step of mapping the triangulation and converting the triangulation into a quadrangulation.

5.5 Claims 36-40 and 42-44 are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential elements, such omission amounting to a gap between the elements. See MPEP § 2172.01.

5.6 Regarding independent claims 36 and 38, each claim preamble is directed to "a computer program product that models a surface of an object" and the omitted elements are the elements that take the results of each claim's final element of "computer-readable program code that homeomorphically maps edges of a coarsest triangulation in the hierarchy back to the initial triangulation" and creating a model of the surface of the object.

5.7 Regarding independent claim 42, this claim's preamble is directed to "an apparatus that generates models of objects" and the omitted elements are the elements that take

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the results of this claim's final element means for "converting the mapped coarsest triangulation to the quadrangulation by matching pairs of adjacent triangles in the coarsest triangulation" and creating a model of the object.

5.8 Claims rejected but not specifically described above are rejected based on their dependency to a rejected independent claim.

Claim Rejections - 35 U.S.C. § 101

6. The following is a quotation of 35 U.S.C. 101:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

6.1 Method claims 1-22 and 46 are rejected for reciting a process that is not directed to the technological arts.

Regarding claims 1, 7, 10, 19-20, and 46, each independent claim is directed at a method of modeling a surface of an object. Independent claim 16 is directed at a method of generating a model of an object. To be statutory, the utility of an invention must be within the technological arts. *In re Musgrave*, 167 USPQ 280, 289-90 (CCPA, 1970). The definition of "technology" is the "application of science and engineering to the development of machines and procedures in order to enhance or improve human conditions, or at least to improve human efficiency in some respect." (Computer Dictionary 384 (Microsoft Press, 2d ed. 1994)).

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The limitations recited in each of claims 1, 7, 10, 16, 19-20, and 46 contain no language suggesting that these claims are intended to be within the technological arts. A claim preamble directed at “a computer-implemented method of modeling a surface of an object” would be considered as within the technological arts.

6.2 Method claims 1-22, 38-40, and 46 are rejected for reciting a process comprising an abstract idea.

6.3 Regarding claims 1, 7, 10, 19-20, and 46, each independent claim is directed at a method of modeling a surface of an object. Independent claim 16 is directed at a method of generating a model of an object. Each of independent claims 36 and 38 is directed at computer program product containing program code for modeling a surface of an object.

The steps recited in each independent claim describe the abstract idea of performing abstract topological manipulations. These steps do not: (1) recite data gathering limitations or post-mathematical operations that might independently limit the claims beyond the performance of a mathematical operation; or (2) limit the use of the output to a practical application providing a useful, concrete, and tangible result..

6.4 Claims rejected but not specifically described above are rejected based on their dependency to a rejected independent claim.

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Claim Rejections - 35 U.S.C. § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

...

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

7.1 Claims 1-2, 36, and 42 are rejected under 35 U.S.C. 102(b) as being anticipated by Dey et al, “Topology Preserving Edge Contraction” (1999)(prior art submitted by Applicants).

7.2 Regarding claim 1, Dey et al teaches a method of modeling a surface of an object, comprising the steps of:

generating from an initial triangulation of the surface, a hierarchy of progressively coarser triangulations of the surface by performing a sequence of edge contractions to the initial triangulation [edge contractions used to perform simplification of initial triangulation “generated through repeated vertex removal”; page 23 Section 1 “Introduction”];

connecting the triangulations in the hierarchy using homeomorphisms [nested hierarchy of complexes created, page 26 column 1; and

homeomorphically mapping edges of a triangulation in the hierarchy back to the initial triangulation [edge contraction is homeomorphic as it preserves the topological type of the initial triangulation].

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Therefore, Dey et al anticipates claim 1.

7.3 Regarding claims 2 and 36, the method of Dey et al inherently homeomorphically maps edges of a coarsest triangulation in the hierarchy back to the initial triangulation.

Claim Rejections - 35 U.S.C. § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8.1 Claims 3, 16, 20-21, 37, and 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dey et al, in view of Ramaswami et al, "Converting Triangulations to Quadrangulations," Computational Geometry: Theory and Applications, pp. 1-27 (1995)(paper available at <http://citeseer.ist.psu.edu/ramaswami95converting.html>).

8.2 Regarding claims 3, 16, 20-21, 37, and 42, the method of Dey et al teaches the steps up to and including homeomorphically mapping edges of a coarsest triangulation in the hierarchy back to the initial triangulation. However, Dey et al does not appear to teach the conversion of the mapped coarsest triangulation into a quadrangulation.

Ramaswami et al teaches the conversion of arbitrarily triangulated domains to quadrangulations. According to Ramaswami et al at page 2 (emphasis in original):

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. . . However, in some situations for both the finite element and the scattered data interpolation problems, it is preferable that the finite elements be *quadrangles* (quadrilaterals) instead of triangles. For example, it has recently been shown that quadrangulations have several advantages over triangulations for the problem of scattered data interpolation [citation omitted] and that improvements in elasticity analysis can be obtained in finite element methods by using quadrangles rather than triangles [citation omitted].

Regarding claims 3, 16, 20, 37, and 42, it would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to combine the conversion of arbitrarily triangulated domains as taught by Ramaswami et al with the homeomorphic mapping of triangulations taught by Dey et al, because the resulting quadrangulations would permit improved finite element analysis.

8.4 Claims 7, 10, 38, and 46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dey et al, in view of Heckbert et al, "Optimal Triangulation and Quadric-Based Surface Simplification," Computational Geometry: Theory and Applications, pp. 1-13 (1999)(paper available at <http://citeseer.ist.psu.edu/heckbert99optimal.html>).

8.5 Regarding claims 7, 10, 38, and 46, the method of Dey et al teaches the steps up to and including homeomorphically mapping edges of a coarsest triangulation in the hierarchy back to the initial triangulation. However, Dey et al does not appear to teach the use of:

- (1) error function to prioritize the edge contractions (claims 7, 10, and 38), and
- (2) a greedy algorithm to select edge contractions (claim 46).

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Heckbert et al teaches a quadric-based simplification using a greedy algorithm to contract the lowest-cost edge. See “2 Quadric-Based Simplification” pages 2-4. According to Heckbert et al at page 2 column 1 paragraph 6:

. . . minimization of the quadric error metric computes curvature information indirectly, and that minimization of this metric yields, in the limit of small triangles, for differentiable surfaces, a triangulation with optimal triangle shape.

Regarding claims 7, 10, 38, and 46, it would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to combine the quadric-based simplification algorithm and error metric as taught by Heckbert et al with the homeomorphic mapping of triangulations taught by Dey et al, because the resulting triangulations would approach optimal triangle shape.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to Applicants' disclosure. Reference to Assa et al, U.S. Patent 6,313,837 is cited as teaching a method of multiresolution analysis using nodes.

10. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Samuel Broda, whose telephone number is (703) 305-1026. The Examiner can normally be reached on Mondays through Fridays from 8:00 AM – 4:30 PM.

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If attempts to reach the Examiner by telephone are unsuccessful, the Examiner's supervisor, Kevin Teska, can be reached at (703) 305-9704. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the group receptionist, whose telephone number is (703) 305-3900.

A handwritten signature in black ink, appearing to read 'S. Broda'.

**SAMUEL BRODA, ESQ.
PRIMARY EXAMINER**